THE RELATION OF THE FOODSTUFFS TO ALIMENTARY FUNCTIONS.

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The great development of experimental research which has taken place in recent years in the study of the digestive functions has inaugurated a variety of new viewpoints in this department of physiology. In the earlier days attention was concentrated upon the processes carried out in the stomach, and the activities of the remainder of the alimentary tract failed to be drawn into consideration. The recognition of the importance of the changes which have their seat in the intestines was the outcome primarily of biochemical investigation. It is not long since we were accustomed and content solely to analyze the changes which the alimentary processes bring about in the foodstuffs—to study the effect of the digestive enzymes upon them, and to investigate the disappearance of the products from the digestive tube. Considerations such as these comprised practically the sum total of alimentation as it was then appreciated.

But instead of recounting the transformations which the foods experience in the digestive processes, instead of debating where and whether fats, carbohydrates, and proteins are completely disintegrated into simpler molecules before they are reconstructed into forms of flesh and blood, another aspect of the alimentary functions has been proposed for this discussion. The familiar query regarding the changes which digestion imparts to the foodstuffs will for once give way to a newer and reversed point of view. Let us inquire what influence the foods have on the alimentary processes. It will appear that, aside from their value as nutrients, the components of the diet exercise specific influences upon the alimentary organs. Are not such physiological agencies an appropriate theme for consideration in the field of therapeutics?

So long as the secretion of the digestive juices and the regulation of the muscular mechanisms of the gastro-intestinal tract were assumed to be under the sole dominance of a nervous apparatus, the *character* of food eaten was destined to play an insignificant part in the secretory and muscular responses. Fat and starch alike were food; and the physiologist was not inclined to discriminate between them in their action on secretion. The gush of chyme in the duodenum, like the bolus of food in the stomach, provoked a flow of digestive secretion by some obscure mechanical agency or some nervous reflex. We have become emancipated from these broad generalizations. Not all foodstuffs provoke secretion in equal degree. Not all constipation is due primarily to failure of peristalsis. The skilled therapeutist of today can well afford to devote to the specific action of the diet the same detailed consideration which he accords to his armamentarium of drugs.

Perhaps the most fruitful and suggestive of the more recent ideas has been that of the *hormones*, or chemical excitants, which travel about the organism. Ever since Bayliss and Starling demonstrated that the flow of the pancreatic juice and the bile can be incited not only by nervous reflexes, but also by the absorption of definite chemical substances which are despatched through the blood stream to the pancreas and liver respectively, and there set up increased secretory activity, speculation has been rife as to the extent to which such chemical regulation of our functions is maintained. We have been taught to recognize the humoral paths of stimulating influences—to appreciate that active chemical agents may travel about the body from part to part, and awaken responses through the circulation as well as through the less direct nervous paths.

One of the newest of these hormones, or chemical excitants, to deserve attention in this connection has lately been brought to notice by Edkins. He has shown that the contact of certain food products with the pyloric end of the stomach gives rise to some chemical substance—a gastric hormone or secretagogue—which acts as a powerful stimulus to gastric secretion when it is introduced into the circulation. In the case of the pancreas, as is well known, the presence of acid in the duodenum awakens a speedy response: in part, this may be due to a nervous reflex; in part, probably also to the formation or liberation of a specific substance (a secretin) in the walls of the intestines, which travels directly to the glands in the blood current and provokes secretion. Now, in the stomach, acid alone is at best a slight stimulus; but dextrins, maltose and dextrose, proteoses, and, above all, extract of meat, are pronounced gastric secretagogues. They do not act from the fundus; but are absorbed in part and act from the pyloric end of the stomach and the duodenum. The first products of digestion, therefore, acting on the pyloric membrane, liberate a substance—the hormone, gastrin—which is absorbed into the blood stream and carried to all the cells of the stomach where it functions as a specific excitant of their secretory activity. Here then is furnished a definite illustration of certain food products arousing the gastric cells. We learn a dietetic method of inducing secretion in the stomach. The psychic flow which comes at the outset of the meal and has been made familiar through the researches of Pawlow is nervous in origin. It can, accordingly, be provoked, modified, or inhibited through purely nervous channels. The later and more prolonged flow of gastric juice is associated with the food derivatives. This food factor in gastric secretion is, by no means, an entirely new conception. The germ of the modern work may be found in the older observations by Schiff. But the work of Edkins and others has emphasized the specific nature of the excitants and the fact that they act directly through absorption and not primarily on a central nervous mechanism. Bouillon or meat soup taken early in the meal soon reaches the pylorus and duodenum and incites a flow of gastric juice. The dextrins and maltose of toasted bread and zwieback perform the same function. We have thus learned an application of dietotherapy to awaken the dormant secretory glands. Abundance of secretion in the stomach in turn promises abundance of pancreatic juice and bile, because of the excitatory function of the gastric hydrochloric acid when it reaches the duodenum. The intestinal secretion is likewise said to be facilitated through the excitation by hormones.

On the other hand, fats are well known to *inhibit* gastric secretion in a striking manner. Thus, the nature of the food intake may materially modify the secretory responses of the alimentary tract and its appendages. The better appreciation and extension of the laboratory studies on the responses of the secretory glands to specific food products already give promise of useful application in the field of clinical medicine. When drugs still largely fail, a carefully selected dietetic regime may succeed in awakening or repressing organs upon the proper secretory function of which our nutritive welfare depends.

There are, furthermore, numerous and significant indirect or secondary influences, which arise from the regulatory function exercised by certain foods upon the alimentary processes. Whatever promotes an abundance of HCl in the stomach and insures its discharge through the pylorus, provokes a liberal flow of bile, and a consequent ready absorption of the digestion products of fats. Again, high or low gastric acidity markedly modifies the extent of the putrefactive changes in the bowel. The relaxation and closure of the stomach sphincters at the cardia and the pylorus are under the control (in large measure) of the reaction which prevails there. Foods which tend (like proteins) to combine with acid and diminish the "free" HCl, or (like fats) to repress acid secretion, will delay the discharge from the stomach. Whatever facilitates speedy accumulation of acid in the pyloric region tends toward an earlier emptying of the organ into the parts beyond. Newer investigations suggest that bile stimulates peristalsis in the intestines. Enough has been said to indicate how intimately and intricately the food influences may involve the ensemble of digestive phenomena.

In this connection, mention may be made of the interesting discovery, by Boldyreff, of the regurgitation of duodenal contents into the stomach under appropriate conditions. This is most likely to occur when the stomach is empty or acid secretion has been repressed to a minimum by ingestion of fats. Pancreatic juice may thus be obtained from the stomach, and the method has already been introduced into clinical usage for the diagnosis of pancreatic conditions. Migaj has suggested that strong acids in the stomach are neutralized by such regurgitations of alkaline duodenal contents. It should be noted, finally, that even peristalsis has been brought under the alleged domination of hormones: Zuelzer claims that at the height of digestion the mucosa of the stomach yields a substance which causes energetic but natural peristalsis extending throughout the intestinal tube. This, like many of the interesting speculations which the introduction of a new idea into physiology has evolved, demands a further critical examination before it deserves to be incorporated with the more permanent acquisitions of our science.

Another and somewhat different conception of the influence of the foodstuffs upon digestive phenomena owes its prominence to the authority of Pawlow. He has taught that the secretory glands may respond in a unique way to variations in the type of foodstuffs ingested. According to him there may be a specific adaptation of the secretions, such as that of the pancreas, so that the richness of the juice in proteolytic, amylolytic, or lipolytic enzyme varies with the nature of the diet. We are taught to speak of "meat" juice, or "bread" juice, or "milk" juice, each varying noticeably in its relative digestive power. It must be admitted that an adaptive response of this sort by which more enzyme of one type or another is produced specifically as it is needed, in reply to the stimulus of the individual foodstuffs, presents a remarkable specificity of physiological function. However, the consensus of opinion at the present moment speaks against such a specific sensibility of the mucous membrane of the alimentary tract, alluring as the idea may be. One of the critics of the adaptation hypothesis (Popielski) naïvely remarks that the welfare of the organism will be better assured if we ourselves conduct the analysis of our foods than if the task is left to the digestive glands. Despite contradictory statements it appears in the case of the saliva that the texture, more than the composition of the food, is a decisive factor in awakening the secretory response.

In addition to this there is, however, a further type of claim which postulates even a more radical adaptation of secretions to the diet. The feeding of specific foods is assumed to induce the formation of desired enzymes, in some cases even when they are never found at all under usual conditions. Much more satisfactory evidence than has yet been offered will be needed to convince the unbiassed physiologist that cells can suddenly assume new roles with the ease which has been claimed—that a few days' feeding with bread or milk sugar, for example, will elicit the production of starch-digesting or sugar-inverting enzymes in secretions in which they are normally wanting. These problems of adaptation are still in the realm of the unproved. As Starling says: "There are riddles enough in physiology without conjuring up a teleological adaptation for which the experimental evidence is inadequate, the conception of the mechanism impossible, and which is not necessary for the well-being of the animal."

Examined from a still different point of view, the food factor is of preëminent significance in relation to alimentary changes. It modifies the extent of the bacterial transformations which go on there; while Metchnikoff and his followers would have us believe that it is possible by dietetic regulation to alter decidedly the bacterial flora of the alimentary tract. The usefulness of lactic acid, sour milk, and lactic acid ferments as curative agents is nothing less than problematical at the present moment. But the very principles underlying their use emphasize the possibility of regulating alimentary changes most profoundly by the character of the food intake and its natural concomitants. The dietotherapy of infants has lately witnessed the advent of a new theory for the etiology of the alimentary intoxications (so-called) of children. Whereas, for a long time attention has primarily been directed to the dangers of the products of the intestinal flora, Finkelstein maintains most emphatically that these familiar disturbances are ofttimes nutritive (metabolic) and digestive in character, rather than more specifically bacterial. He directs attention to the food rather than the ferments in the treatment of these infantile disorders. "Food intoxication," if we may coin the expression, is by no means a novelty; nor are we prepared as yet to realize its possible consequences. A secretory function fails; fats are improperly absorbed; the fatty acids form soaps of calcium, robbing the growing organism of its supply of lime, which is wasted with the stools; acidosis intervenes. What a serious train of symptoms can here be avoided by a timely consideration of the relations of food to the alimentary processes. Drug medication is of insignificant moment amid such complications. The possibilities of the newer knowledge of the laboratory must be translated into practice and there made effective. As Professor Ewing has appropriately remarked in another connection: "The feeding of healthy man, as well as the diet of the sick, cannot be left to chance, guided by appetite, or ruled by tradition, but can be safely directed only according to the laws of digestion and metabolism."

DIET AND THE CARE OF THE BOWELS IN TYPHOID FEVER.

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"Lack of perception is the devil's best friend."

Typhoid fever is characterized by infection, and in the vast majority of cases by local ulceration in the ileum and the cecum. The prognosis in normal individuals depends upon the degree of the infection and the extent of the local ulceration in the intestine.